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(54) **DIGITAL SIGNAL PROCESSING METHODDIGITAL SIGNAL PROCESSING UNITDIGITAL SIGNAL RECORDING METHODDIGITAL SIGNAL RECORDERRECORDING MEDIUMDIGITAL SIGNAL TRANSMISSION METHOD AND DIGITAL SIGNAL TRANSMITTER**

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the static characteristic and the sound quality by conducting an adjustment operation depending on an input digital signal and realizing more efficient coding with a proper processing amount resulting from the adjustment operation.
SOLUTION: In the case of calculating a bit share amount for each 2-dimension block with respect to time and frequency and a total number of assigned bits for all the 2-dimension blocks is not matching a bit rate specified by a coding format depending on a result of integer processing of the bit share amount or the likean arithmetic means in a bit assignment calculation circuit 118 calculates a maximum possible quantization error in the 2-dimension blocks based on the bit assigned amount calculated tentatively and normalized data or a maximum signal component in the 2-dimension blocks for each 2-dimension block with respect to time and frequency in order to make them match each otherand conducts the adjustment operation of bits based on the bit necessity by recognizing the maximum quantization error as the bit necessity of each 2-dimension block.

CLAIMS

[Claim(s)]
[Claim 1]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and

frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculatedDetermine bit allocation quantities based on this quantization coefficientfor every two-dimensional block about the above-mentioned time and frequencyquantize a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand carry out an information compressionand. In a digital signal processing method which obtained an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockWhen bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisFor every two-dimensional block about the above-mentioned time and frequency the amount of bit assignment computed provisionallynormalization dataor based on the greatest signal component within a two-dimensional blockA digital signal processing method computing the greatest quantization error that may happen within a two-dimensional blockconsidering that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand performing adjustment operation of a bit based on this bit necessity degree.

[Claim 2]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculatedDetermine bit allocation quantities based on this quantization coefficientfor every two-dimensional block about the above-mentioned time and frequencyquantize a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand carry out an information compressionand. An information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block is obtainedIn time by which the information compression was carried out [above-mentioned]and a digital signal processing method which decoded a signal component within two or more two-dimensional blocks related with frequency using an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockWhen bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency and a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding format by a relation which performs integer-ization of bit allocation quantitiesetc.in order to coincide thisThe amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequencyOr a digital signal processing method computing the greatest quantization error that may happen within a two-dimensional block based on the greatest signal component within a two-dimensional blockconsidering that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand performing adjustment operation of a bit based on this bit necessity degree.

[Claim 3]A zone division means to divide an input digital signal into two or more frequency band components.
An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequencyor analysis.
A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand obtains normalization data.
A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency.
A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficientA compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand carries out an information compression for every two-dimensional block about the above-mentioned time and frequencyand an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.
When it is the digital signal processing device provided with the above and bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequencyOr based on the greatest signal component within a two-dimensional blockthe greatest quantization error that may happen within a two-dimensional block was computedit considered that a quantization error of this maximum was a bit necessity degree of two dimension blocks eachand a means to perform adjustment operation of a bit based on this bit necessity degree was formed.

[Claim 4]A zone division means to divide an input digital signal into two or more frequency band components.
An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequencyor analysis.
A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand obtains normalization data.
A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency.
A bit distribution calculating means which determines bit allocation quantities based on this quantization coefficientA compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit

allocation quantitiesand carries out an information compression for every two-dimensional block about the above-mentioned time and frequencyAn information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockTime by which the information compression was carried out [above-mentioned]and a decoding means which decodes a signal component within two or more two-dimensional blocks related with frequency using an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional block.
When it is the digital signal processing device provided with the above and bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequencyOr based on the greatest signal component within a two-dimensional blockthe greatest quantization error that may happen within a two-dimensional block was computedit considered that a quantization error of this maximum was a bit necessity degree of two dimension blocks eachand a means to perform adjustment operation of a bit based on this bit necessity degree was formed.

[Claim 5]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculatedDetermine bit allocation quantities based on this quantization coefficientand for every two-dimensional block about the above-mentioned time and frequencyquantize a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand an information compression is carried outIn a digital signal record method recorded on a recording medium with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockWhen bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisFor every two-dimensional block about the above-mentioned time and frequency the amount of bit assignment computed provisionallynormalization dataor based on the greatest signal component within a two-dimensional blockA digital signal record method computing the greatest quantization error that may happen within a two-dimensional blockconsidering that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand performing adjustment operation of a bit based on this bit necessity degree.

[Claim 6]A digital signal recorder comprising:
A zone division means to divide an input digital signal into two or more frequency band components.
An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component within time and two or more two-dimensional blocks related with frequency.
A normalization data calculating means which normalizes for every two-dimensional block about the above-mentioned time and frequency based on a signal component for coding within a two-dimensional blockor analysisand obtains normalization data.
A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyA bit distribution calculating means which determines bit allocation quantities based on this quantization coefficientA compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand carries out an information compression for every two-dimensional block about the above-mentioned time and frequencyIt has an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockIn a digital signal recorder which recorded both outputs of the above-mentioned compression coding means and the above-mentioned information-compression parameter determination means on a recording mediumWhen bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe greatest quantization error that may happen within a two-dimensional block is computed for every two-dimensional block about the above-mentioned time and frequency based on the greatest signal component within the amount of bit assignment computed provisionallynormalization dataor a two-dimensional blockA means to consider that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand to perform adjustment operation of a bit based on this bit necessity degree.

[Claim 7]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculatedDetermine bit allocation quantities based on this quantization coefficientand for every two-dimensional block about the above-mentioned time and frequencyquantize a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand an information compression is carried outIn a recording medium recorded with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockWhen bit allocation quantities are

computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe greatest quantization error that may happen within a two-dimensional block is computed for every two-dimensional block about the above-mentioned time and frequency based on the greatest signal component within the amount of bit assignment computed provisionallynormalization dataor a two-dimensional block. A recording medium considering that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand performing adjustment operation of a bit based on this bit necessity degree.

[Claim 8]Divide an input digital signal into two or more frequency band componentsand a signal component within time and two or more two-dimensional blocks related with frequency is obtainedNormalize based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequency is calculatedDetermine bit allocation quantities based on this quantization coefficientand for every two-dimensional block about the above-mentioned time and frequencyquantize a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand an information compression is carried outIn a digital signal transmission method which transmits with an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockWhen bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisFor every two-dimensional block about the above-mentioned time and frequency the amount of bit assignment computed provisionallynormalization dataor based on the greatest signal component within a two-dimensional blockA digital signal transmission method computing the greatest quantization error that may happen within a two-dimensional blockconsidering that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand performing adjustment operation of a bit based on this bit necessity degree.

[Claim 9]When bit allocation quantities are computed for every two-dimensional block about the above-mentioned time and frequency in a digital signal sending set characterized by comprising the followingby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about the above-mentioned time and frequencyOr based on the greatest signal component within a two-dimensional blockthe greatest quantization error that may happen within a two-dimensional block is computedA digital signal sending set forming a means to consider that a quantization error of this maximum is a bit necessity degree of two dimension blocks eachand to

perform adjustment operation of a bit based on this bit necessity degree.
A zone division means to divide an input digital signal into two or more frequency band components.
An orthogonal transformation means which carries out orthogonal transformation of the signal and obtains a signal component for coding within time and two or more two-dimensional blocks related with frequencyor analysis.
A normalization data calculating means which normalizes based on a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyand obtains normalization data.
A quantization coefficient calculating means which calculates a quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about the above-mentioned time and frequencyA bit distribution calculating means which determines bit allocation quantities based on this quantization coefficientA compression coding means which quantizes a signal component within a block with the above-mentioned normalization data and bit allocation quantitiesand carries out an information compression for every two-dimensional block about the above-mentioned time and frequencyA transmitting means which transmits both outputs of an information-compression parameter determination means which obtains an information-compression parameter for every [about the above-mentioned time and frequency] two-dimensional blockand the above-mentioned compression coding means and the above-mentioned information-compression parameter determination means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to a digital signal processing methoda digital signal processing devicea digital signal record methoda digital signal recordera recording mediuma digital signal transmission methodand a digital signal sending set.
[0002]
[Description of the Prior Art]Although it is in the conventional method and device of high efficiency coding of an audio signal variouslythe example of 2 and 3 of a conventional example is explained below. The audio signal of a segment of time is blocked for every unit timeand the signal of the time-axis for this the block of every is changed into the signal on a frequency axis (orthogonal transformation)it divides into two or more frequency bandsand there is the conversion coding method which is one of the blocking frequency-band-division methods coded for every zone. There is the zone part tally item-ized {subband coding (SBC:Subband Coding)} method which is one of the deblocking frequency-band-division methods divided and coded to two or more frequency bands without blocking the audio signal of a segment of time for every unit time. There is also a highly efficient encoding method which combined the above-mentioned formation of a zone part tally item and conversion coding. In this caseafter performing zone division by the above-mentioned zone part tally item-ized

methodorthogonal transformation of the signal for every zone of that will be carried out to the signal of a frequency domain by the above-mentioned conversion coding methodand it will code for each [by which orthogonal transformation was carried out] of this zone of everyfor example.
[0003]As a filter for zone division used for the zone part tally item-ized method mentioned above hereFor examplethere is a filter of a mulberry DORACHA mirror filter (QMF:Quadrature MirrorFilter) etc.This is 1976 R.E.Crochiere Digital coding ofspeech in subbands Bell Syst.Tech. J. Vol.55 and No.8. It is stated to 1976. To ICASSP 83 and BOSTON Polyphase Quadrature filters-A new subbandcoding technique Joseph H. Rothweiler. a polyphase mulberry DORACHA filter (PQF: Polyphase Quadrature filter) etc. -- etc. -- the filter split method and device of the bandwidth are described.
[0004]As orthogonal transformation mentioned abovean input audio signal is blocked by prescribed unit time (frame)for exampleThere is a method that a time-axis is changed into a frequency axis by performing Fast Fourier Transform (FFT)a discrete cosine transform (DCT)modified DCT transformation (MDCT)etc. for the block of every. To above-mentioned MDCT. ThereforeICASSP 1987 Subband/Transform Coding Using Filter Bank DesignsBased on Time Domain Aliasing Cancellation J.P.Princen. A.B. It is stated to BradleyUniv. of Surrey Royal Melbourne Inst.of Tech.
[0005]There is zone division in consideration of human being's aural characteristic as frequency division width in the case of quantizing each frequency component by which frequency band division was carried out. That isan audio signal may be divided into the zone of two or more bands (for example25 bunt) with the bandwidth that bandwidth becomes large as the high region currently generally called the critical band (critical band). When coding the data for every zone at this timepredetermined bit distribution or coding according to accommodative bit distribution the whole zone is performed for every zone. For examplewhen coding the MDCT coefficient data produced by MDCT processing of the **** being carried out by above-mentioned bit distributioncoding will be performed with the accommodative distribution number of bits to the MDCT coefficient data for every zone obtained by the MDCT processing for every above-mentioned block.
[0006]What is called block floating (BlockFloating: block floating) processing in which more efficient coding is realized is performed by quantizing by normalizing for every zone on the occasion of the coding for every zone. Namelywhen coding the MDCT coefficient data produced by MDCT processing of the **** being carried outit quantizes by performing normalization corresponding to the maximum of the absolute value of an above-mentioned MDCT coefficientetc. for every zone. Thereby more efficient coding is performed.
[0007]As an above-mentioned bit distribution methodthe two following methods are known conventionally. In IEEE Transactions of AccousticsSpeechand Signal Processingvol.ASSP-25No.4and August 1977bit distribution is performed based on the size of the signal for every zone. .ICASSP 1980 The critical. In band coder - digital encoding ofthe perceptual requirements of the auditory system M.A. Kransner MITby using auditory masking. The method of obtaining a required signal to noise ratio for every zoneand performing fixed bit distribution is described.
[0008]
[Problem(s) to be Solved by the Invention]By the waywhen the bit allocation quantities

for every zone which quantizes are computed in the conventional highly efficient encoding method and device which were mentioned aboveSince the total of the quota bit of all the zones generally is not in agreement with the bit rate specified by a coding format by the relation which performs integer-ization of bit allocation quantitiesetc.bit adjustment operation is needed in order to coincide this. Although how to perform by the priority for which it depended on frequency simply as this bit adjustment operationfor example can be consideredit will not be dependent on an input signal at all in this caseand adapted adjustment operation cannot be performed. howeverthe case where bit adjustment depending on an input signal is performed strictly -- all the signal components -- a quantization error -- it will be necessary to take a masking effect etc. into consideration againand processing will become large dramatically as adjustment operation.

[0009]This invention is made in view of such the actual conditionand an input digital signal is divided into two or more frequency band componentsObtain the signal component within time and two or more two-dimensional blocks related with frequencyand normalize based on the signal component within a two-dimensional block for every two-dimensional block about time and frequencyand normalization data is obtainedThe quantization coefficient which expresses the feature of the signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculatedDetermine bit allocation quantities based on the quantization coefficientfor every two-dimensional block about time and frequencyquantize the signal component within a block with normalization data and bit allocation quantitiesand carry out an information compressionand. A digital signal processing method which obtained the information-compression parameter for every [about time and frequency] two-dimensional blockA digital signal processing devicea digital signal record methoda digital signal recordera recording mediuma digital signal transmission methodOr in a digital signal sending setadjustment operation depending on an input digital signal is performedmore efficient coding is realized by a throughput suitable as adjustment operationand what can aim at improvement in a static characteristic or a signal quality is proposed.

[0010]

[Means for Solving the Problem]This invention divides an input digital signal into two or more frequency band componentsObtain a signal component within time and two or more two-dimensional blocks related with frequencyand normalize based on a signal component within a two-dimensional block for every two-dimensional block about time and frequencyand normalization data is obtainedA quantization coefficient which expresses the feature of a signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculatedDetermine bit allocation quantities based on the quantization coefficientfor every two-dimensional block about time and frequencyquantize a signal component within a block with normalization data and bit allocation quantitiesand carry out an information compressionand. In a digital signal processing method which obtained an information-compression parameter for every [about time and frequency] two-dimensional blockWhen bit allocation quantities are computed for every two-dimensional block about time and frequencyby a relation which performs integer-ization of bit allocation quantitiesetc. When a total of a quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a

coding formatin order to coincide thisFor every two-dimensional block about time and frequency the amount of bit assignment computed provisionallynormalization dataor based on the greatest signal component within a two-dimensional blockThe greatest quantization error that may happen within a two-dimensional block is computedit considers that the greatest quantization error is a bit necessity degree of two dimension blocks eachand adjustment operation of a bit is performed based on the bit necessity degree.

[0011]According to the digital signal processing method of this this inventionadjustment operation depending on an input digital signal can be performedmore efficient coding can be realized by a throughput suitable as adjustment operationand improvement in a static characteristic or a signal quality can be aimed at.

[0012]

[Embodiment of the Invention]Hereafteran embodiment of the invention is described with reference to drawings. In this embodimentinput digital signalssuch as an audio PCM signalHigh efficiency coding is carried out using each art of the formation (SBC) of a zone part tally itemadaptive transform coding {adaptive transformation coding (ATC:Adaptiv Transform Coding)}and adaptation BITSUTO assignment. This art is explained referring to drawing 1 or subsequent ones.

[0013]In the concrete high-efficiency-coding encoder shown in drawing 1. Divide an input digital signal into two or more frequency bandsand perform orthogonal transformation for every frequency bandand the spectrum data of the obtained frequency axis in low-pass. what is called every [in consideration of human being's aural characteristic mentioned later] critical band width (critical band) -- junior and senior high schools -- in the regionfor every zone which subdivided critical band width in consideration of block flow TEIGU efficiencyBITSUTO assignment was carried out accommodative and it has coded. Usuallythis block turns into a quantization noise generating block. In an embodiment of the inventionblock size (block length) is changed accommodative according to an input signal before orthogonal transformation.

[0014]namelyPCM after the sampling frequency was sampled for the audio signal of a 0-22-kHz frequency band by 44.1 kHz in drawing 1for example -- the input audio PCM signal acquired by-izing [a PCM signal] is supplied to the input terminal 100. This input audio PCM signal is divided into a 0-11-kHz zoneand 11 kHz - a 22-kHz zone by the zone dividing filters 101such as what is called a QMF (mulberry DORACHA mirror filter) filterfor example. Similarly the signal of a 0-11-kHz zone is divided into a 0 - 5. 5kHz zone and 5. 5 kHz - 11-kHz zone by the zone dividing filters 102such as what is called a QMF filter.

[0015]The signal of 11 kHz - the 22-kHz zone from the above-mentioned zone dividing filter 101The MDCT (Modified Discrete Cosine Transform) circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 103 which is an example of an orthogonal transformation circuit is suppliedand MDCT processing is carried out. The signal of 5. 5 kHz - 11-kHz zone from the zone dividing filter 102 is supplied to MDCT circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 104and MDCT processing is carried out. The zone dividing filters 102-0 - 5. 5kHz zone signal are supplied to MDCT circuit (modified one and discrete cosine transform means) (orthogonal transformation means) 105and MDCT processing is carried out. In each MDCT circuits 103104and 105MDCT processing is

made based on the block size (information-compression parameter) (the length of a processing block) determined by the block determining circuits 109110and 111 provided for every zone.

[0016]As mentioned aboveas a means to divide an input digital signal into two or more frequency bandsthere is a QMF filterfor examplebut. About thisit is 1976 R.E.CrochiereDigital Coding of Speech In Subbands Bell Syst.Tech. J. Vol.55 and No.8. It is stated to 1976. The filter split method of the ** bandwidth is stated to ICASSP 83 and Boston Polyphase Quadrature Filters-ANew Subband Coding Technique Joseph H. Rothweiler. As orthogonal transformation mentioned abovean input audio signal is blocked by prescribed unit time (frame) herefor exampleThe orthogonal transformation which changed the time-axis into the frequency axis occurs by performing Fast Fourier Transform (FFT)a discrete cosine transform (DCT)modified DCT transformation (MDCT)etc. for the block of every. To MDCT. ThereforeICASSP 1987 Subband/TransformCoding Using Filter Bank Designs Based On Time Domain AliasingCancellation J.P.Princen A. B. It is stated to Bradley Univ.of Surrey Royal MelbourneInst. Of Tech.

[0017]Herethe example over the standard input digital signal about the block for every zone supplied to each MDCT circuits 103104and 105 is shown in drawing 2. Three filter output signals have two or more orthogonal transformation block sizes respectively independently for every zoneand he is trying to have time resolution switched by the time characteristics of a signalfrequency distributionetc. in the example of this drawing 2. a signal -- time -- semi- -- in being steadyit enlarges orthogonal transformation block size with 11.6mS like the long mode of drawing 2 A. When a signal is unsteady-likeorthogonal transformation block size is considered as further 2 division and quadrisection. Namelylike the short mode of drawing 2 B like the case where all are made into the time resolution of quadrisectioni.e.2.9mSthe middle mode A of drawing 2 Cand the middle mode B of drawing 2 DIt is adapted for a actual complicated input digital signal by making a part into two divisioni.e.5.8mSand making other one copy into the time resolution of quadrisectioni.e.2.9mS. The more effective thing is clearif the scale of a processing unit allows division of this orthogonal transformation block size and still more complicated division will be performed.

[0018]A decision of this orthogonal transformation block size is made in the determining circuits (determination means of orthogonal transformation block size) 109110and 111 of orthogonal transformation block sizeThe decision results are supplied to each MDCT circuits 103104and 105 and the bit quota calculation circuit 118and they are outputted from the output terminals 113115and 117 as block size information on a block (information on the length of a processing block) (information-compression parameter).

[0019]The spectrum data on the frequency axis produced by MDCT processing being carried out in each MDCT circuits 103104and 105Or MDCT coefficient data (signal component within the two-dimensional block about time and frequency)low-pass is summarized to what is called every critical band (critical band) -- junior and senior high schools -- in consideration of the validity of block floatinga region subdivides critical band width and is supplied to the adaptation bit allocation code-ized circuits 106107and 108 and the bit assignment calculation circuit 118.

[0020]This seaside zone (critical band) is a frequency band divided in consideration of human being's aural characteristicand is a zone which that noise in case the mask of the

pure sound is carried out by the narrow-band band noise of the same strength near the frequency of a certain pure sound has. In this critical band (critical band)bandwidth is large like the high region and the perimeter wave number zone which is above-mentioned 0-22 kHz is divided into the critical band of 25.

[0021]The bit quota calculation circuit 118 takes into consideration what is called a masking effect etc. based on above-mentioned block size information and spectrum dataor MDCT coefficient dataEnergy or a peak value for every masking quantity and isomerism rate zone for every partition-bands region in consideration of an above-mentioned critical band and block floatingetc. is computedit asks for the quota number of bits for every zone based on the resultand the adaptation bit allocation code-ized circuits 106107and 108 are supplied. In these adaptation bit allocation code-ized circuits 106107and 108. Above-mentioned block size information (information-compression parameter) (the length of a processing block)And according to the number of bits assigned for each [in consideration of a critical band and block floating] partition-bands region of everyit is made to carry out re quantization (it normalizes and quantizes) of each spectrum data or the MDCT coefficient data. Thusthe coded data is taken out via the output terminals 112114and 116 in drawing 1. Each partition-bands region which took into consideration below the above-mentioned critical band and block floating of explanation which serve as a unit of bit assignment for convenience is made into ** called a unit block.

[0022]Nextthe concrete method of the bit assignment performed in the bit assignment calculation circuit 118 in above-mentioned drawing 1 is explained with reference to drawing 3. Drawing 3 is a block circuit diagram showing the outline composition of one example of the bit assignment calculation circuit 118 in above-mentioned drawing 1. In this drawing 3the block size information from the spectrum data on the frequency axis from MDCT circuits 103104and 105 in above-mentioned drawing 1 or a MDCT coefficientand the block determining circuits 109110and 111 in above-mentioned drawing 1 is supplied to the input terminal 301. Henceforthin the system of the bit assignment calculation circuit 118 in above-mentioned drawing 1 shown by drawing 3it processes using a constanta weighting functionetc. which were adapted for above-mentioned block size information.

[0023]In drawing 3the spectrum data or the MDCT coefficient on the frequency axis inputted from the input terminal 301The energy calculation circuit (every zone energy calculation means) 302 is suppliedand the energy for every unit block is searched for by calculating total of each amplitude value within a unit blockfor example etc. The peak value of amplitude valueaverage valueetc. may be used instead of the energy for every band of this. As an output from this energy calculation circuit 302the spectrum of the total value of each band is shown in drawing 6 as SBfor example. Howeverat this drawing 6in order to simplify a graphic displaythe number of partitions by unit block is expressed by 12 blocks (B1 - B12). The dashed line of drawing 6 shows the influence which spectrum SB of the total value of each band has on other portionsand corresponds to weighting of a convolution.

[0024]In the energy calculation circuit 302it shall determine also about the scale-factor (normalization data) (information-compression parameter) value which shows the state of block floating of a unit block and which is normalization data.While preparing some positive values as a candidate of a scale-factor value concrete for example beforehand

and taking the value more than the spectrum data within a unit blockor the maximum of the absolute value of a MDCT coefficient from the insideit adopts as a scale-factor value of a unit block of the minimum thing. What is necessary is to be a actual value and a form where it correspondedto assign a number and just to make the number memorize by ROM (not shown) etc. about a scale-factor value using several bits. The scale-factor value determined by the above-mentioned method in a certain unit block is used as sub information which shows the scale factor of a unit block of the number were numbered using the above-mentioned bit corresponding to the determined value.
[0025]Nextin order to take into consideration the influence what is called in masking of above-mentioned spectrum SB calculated in the above-mentioned energy calculation circuit 302reefing (convolution) processing which hangs and adds a predetermined weighting function to the spectrum SB is performed. For this reasoneach value of the output of the energy calculation circuit 302 for every above-mentioned zonei.e.that spectrum SBis supplied to the reefing filter network 303. The reefing filter network 303 comprises two or more delay elements which delay input data one by onetwo or more multipliers which carry out the multiplication of the filter factor (weighting function) to the output from these delay elementsand a total adding machine which takes total of each output multiplier. By this reefing processingtotal of the portion shown by the drawing 6 middle point line is obtained.
[0026]Nextthe output of the above-mentioned reefing filter network 303 is supplied to the subtraction machine (composing device) (synthesizing means) 304 (subtraction means). The subtraction machine 304 asks for the level alpha corresponding to the noise level (allowable noise level) (quantization coefficient) in which the permission in the collapsed above-mentioned field mentioned later is possible. The level alpha corresponding to a permissible noise level is a level which turns into an allowable noise level for every band of a critical band by performing reverse convolution processingas mentioned later. Herethe admissible function (function expressing a masking level) for asking for the above-mentioned level alpha is supplied to the above-mentioned subtraction machine 304. The above-mentioned level alpha is controlled by making this admissible function fluctuate. The admissible function is supplied from the function generating circuit (n-ai) 305 which is explained below. [0027]That isif the number given sequentially from low-pass [of the band of a critical band] is set to iit can ask for the level alpha corresponding to an allowable noise level by the several 1 following formula.
[0028]
[Equation 1]Alpha=S - (n-ai)
[0029]The bark spectrum (Bark Spectrmu) (it is a unit of a critical band and) by which reefing processing of a> 0 and the S was carried out by the constant in this several 1 formula as for n and a What was represented as one spectrum to one critical band. It is intensity and the inside (n-ai) of the formula of several 1 serves as an admissible function. n= 38 and a= 1 can be used as an example.
[0030]Thusthe above-mentioned level alpha is called for and this data is supplied to the divider 306. It is for carrying out the reverse convolution of the above-mentioned level alpha in an above-mentioned field by which the reefing was carried out in the divider 306. Thereforea masking spectrum comes to be acquired from the above-mentioned level alpha by performing this reverse KOMBORI U-SHIN processing. That isthis masking spectrum turns into a permission noise spectrum. Although above-mentioned reverse

convolution processing needs a complicated operationit is performing a reverse convolution using the simplified divider 306 in this embodiment.

[0031]Nextan above-mentioned masking spectrum is supplied to the subtractor 308 via the synthetic circuit 307. Hereit is supplied to the subtractor circuit 308 via the delay circuit 309above-mentioned outputi.e.spectrum SB mentioned abovefrom the energy detector circuit 302 for every zone. Thereforeas shown in drawing 7 by subtraction operation of an above-mentioned masking spectrum and spectrum SB being performed in this subtractor circuit 308below a level in which above-mentioned spectrum SB is shown on a level of that masking spectrum MS will be masked.

[0032]By the wayin the case of composition in the synthetic circuit 307 mentioned abovedata in which what is called minimum audible curve RC that is the aural characteristic of human being as shows drawing 8 supplied from the minimum audible curve generation circuit 312 is shownand above-mentioned masking spectrum MS are compoundable. In this minimum audible curveif a noise absolute level becomes below in this minimum audible curvethat noise can be heard. Even if this minimum audible curve has the same codingit becomes that which differs by difference in a reproduction volume at the time of reproductionbut in a realistic digital system. For examplesince there is no difference in how so muchif quantization noise of a frequency band near 4 kHz which an ear hears easiliest cannot be heardfor examplein other frequency bandsit is thought that quantization noise below a level of this minimum audible curve cannot be heard. [music to 16 BITSUTO dynamic range] Thereforeit is assumed that usage depending on which noise near 4 kHz of word length which a system has in this way cannot be heard is carried outWhen an allowable noise level is obtained by compounding both this minimum audible curve RC and masking spectrum MSan allowable noise level in this caseIn addition it can carry out now to to a portion shown with a slash in drawing 8in this embodimentthe 4-kHz level of the above-mentioned minimum audible curve is setfor example by a minimum level of 20 BITSUTO. This drawing 8 also shows signal-spectrum SS simultaneously.

[0033]Thenin the permissible noise correction circuit (permissible noise compensation means) 310allowable noise level in an output from the above-mentioned subtractor 308 is amended based on information on an equal loudness curve. It connected with a curve in quest of sound pressure of a sound in each frequency which it is hereand an equal loudness curve is a characteristic curve about human being's aural characteristicfor examplethe same size as a pure sound of 1 kHz hearsand is also called an equal loudness contour of loudness. minimum audible curve RC which showed drawing 8 these loudness level contours -- abbreviated -- the same curve is drawn. In these loudness level contoursfor example near 4 kHzeven if sound pressure falls by 8-10 dB from a place of 1 kHzthe same size as 1 kHz hearsand unless it is higher than sound pressure in 1 kHz about 15 dBnear 50 Hzthe same size does not hear conversely. For this reasonnoise (allowable noise level) beyond a level of the above-mentioned minimum audible curve is understood that it is good to have a frequency characteristic given in a curve according to those loudness level contours. Such a thing shows that amending an above-mentioned allowable noise level in consideration of above-mentioned loudness level contours conforms to human being's aural characteristic. Based on various parameterssuch as masking mentioned above by a series of processings so far in the permissible noise correction circuit 310and an aural characteristicit assigns provisionally to each unit

blockand a bit is computed.
[0034]A total which totaled a quota bit provisionally computed by the processing so far for every unit block in the permissible noise correction circuit 310Since it is not in agreement with the usable number of bits generally determined by the bit rate of coding equipmentremedial operation for coinciding this is performed. When there are few totals which totaled a computed above-mentioned quota bit as this correcting method maintained a relative relation during a unit block of a quota bit computed for every unit block than the usable number of bitsWhat is necessary is just to reduce the whole quota number of bits uniformlyas drawing 10 shows when there are more totals which totaled a quota bit which pulls up the whole quota number of bits uniformly as drawing 9 shows andby which **** was computed than the usable number of bits. That isfrom the permissible noise correction circuit 310a quota bit of each unit block after performing this remedial operation is outputted. Although an example performed about this remedial operation in the above-mentioned permissible noise correction circuit 310 was shownwhen performing fraction adjustment later mentioned in a stage of final processing after this compensation process in a series of processings in drawing 3it is also possible to carry out in a stage before the above-mentioned permissible noise correction circuit 310.
[0035]Since a bit assigned value of each unit block which can be found by a series of processings but so far so that it is possible to make mostly into the same number a total which totaled a quota bitand the usable number of bits by above-mentioned remedial operation is computed as the real valueit will need to perform integer-ization by omission etc. practically. It will be necessary to perform integer-ization as a bit assigned value of a range allowed in a format of coding also with a unit block computed more mostly than the maximum bit assignment number allowed in a format of codingand a unit block computed by above-mentioned remedial operation as a negative value. Generallyby operation of this integer-izingthe usable number of bits again determined by a total and the bit rate of a quota bit will not be in agreementand remainder of a bit or shortage of a bit will arise. When there are few totals which totaled a computed quota bit at this time than the usable number of bitsa bit will be leftand in order to perform more efficient codingoperation which assigns a surplus usable bit as much as possible is needed. Since it cannot code correctly when a bit is insufficient of more totals which totaled a computed quota bit conversely than the usable number of bitsoperation of decreasing the quota number of bits is needed. Hereafteradjustment operation which is needed by integer-ization in within the limits of this coding formatetc. is made into a thing of explanation called fraction adjustment for convenience.
[0036]Bit assignment which is normalization data and word length which are the scale factors (normalization data) (information-compression parameter) of each unit block in the fraction equalization circuit 313 in drawing 3Or from the greatest signal component within a unit blockthe greatest quantization error that may happen within each unit block is computedand it is made to perform fraction adjustment operation for a size of this greatest quantization error based on this as a bit necessity degree of each unit block.
[0037]Belowa calculating method of the greatest quantization error used as an index of a bit necessity degree of each unit block in the fraction equalization circuit 313 is explained.
[0038]Firstdata which processed an orthogonal transformation output spectrum obtained as main information by sub information using drawing 11An example of coding by word

length which shows a scale factor (normalization data) (information-compression parameter) and a word size who show a state of block floating obtained as sub information is explained. Drawing 11 is the example which showed a situation of a unit block when bit assignment becomes a triplet. A vertical axis shows a size of spectrum data which set a center to 0or a MDCT coefficientand a horizontal axis shows frequency. In this examplein a unit blockeight spectrum data or a MDCT coefficient shown by abcdefgand h existsand it has a size for Masakata or in a negative direction from 0respectively. A scale factor which shows a state of block floating as mentioned above prepares a positive value in some sizes beforehandWhile taking a value more than spectrum data within a unit blockor the maximum of an absolute value of a MDCT coefficient from the insidethe minimum thing is adoptedand it is considered as a scale factor of a unit block.

[0039]A scale-factor value is chosen in drawing 11 by the spectrum a which shows the maximum of an absolute value. Quantization width within a unit block is determined by size of this scale factor and bit assignment. Although it is possible to express an octal when coding by a triplet originally (quantization) although an example of drawing 11 shows a case where bit assignment is a tripletHerequantization width of a division-into-equal-parts rate is taken ternary every for Masakata and to a negative direction focusing on 0a quantized value of seven values is taken in accordance with 0and another numerals which can be expressed by a triplet suppose that it is intact. Herefrom a scale-factor value and a bit assigned value within a unit blocka quantized value is determined and spectrum data or a MDCT coefficient within a unit block is quantized by the nearest quantized value. A portion of a black dot in drawing 11 shows a value by which each spectrum data or a MDCT coefficient within a unit block was quantized. That isdrawing 11 shows an example of re quantization (it normalizes and quantizes).

[0040]If quantization width in a case of quantizing in a form which generally has the quantization width of a division-into-equal-parts rate for Masakata and in a negative direction focusing on 0 by a method as shown by drawing 11 is set to QVWhen a value of the unit Brock's scale factor is set to SF and it sets a bit assignment number to Nbit can ask for a certain unit Brock's quantization width QV by the following several 2 formulas.

[0041]

[Equation 2]$QV=SF/\{2^{(Nb-1)}-1\}$

HoweverNb>=2 [0042]In this casethe greatest quantization error that may happen within unit Brock is set to QV/2 of the half of quantization width.

[0043]Bit assignment about unit Brock of 0. Since all the spectra or MDCT data in unit Brock will be quantized by 0the greatest quantization error that may happen within unit Brock in this case serves as the maximum of the spectrum in unit Brockor the absolute value of MDCT data.

[0044]When the size of unit Brock's quantization noise is considered hereconsideration of the number of the spectrum included in unit Brock and the size of a actual quantization error is needed strictlybut. Since calculation is needed about all the spectraprocessing will become very large and is not so practical. howeverthe greatest quantization error that may happen within unit Brock who asked by the above methods when there is no remarkable difference in the number of the spectrum in unit Brock -- for a slack reasona possibility that quantization noise will become large highly a larger thing. Since it can consider that a bit necessity degree is large in simple and what is necessary is just to calculate by unit

Brockas compared with the case where it calculates about all the spectrait becomes possible about processing to decrease substantially.

[0045]In the fraction equalization circuit 313by using an above-mentioned method firstthe greatest quantization error that may happen with each unit block about all the unit blocks is computedand let this value be a bit necessity degree of each unit block. Thenfor examplethere are few totals which totaled a computed quota bit than the usable number of bitsand when a bit has arisen not mucha bit necessity degree detects the greatest unit blockand assigns a bit not much to the unit block. About a unit block which was newly able to assign a bit not muchit is a bit assignment value after bit assignment not muchand a bit necessity degree is recomputed by an above-mentioned method. Henceforthin the fraction equalization circuit 313a bit necessity degree detects the greatest unit blockand as long as calculation of assignment of a bit and a bit necessity degree can do again not much and a bit can assign processing of a series of ** not muchit repeats. By a number of a spectrum within a unit block which a bit of the biggest value already allowed by a coding format is assigned at this timeand cannot increase bit assignmentand a unit block. What is necessary is just to except the unit block from an adjustment operation objectwhen a bit is seldom sufficient quantity to increase bit assignment of a unit block. Bit remainder regulated treatment is performed in the fraction process circuit 313and also it can also be performed in the coding correction circuit 314. Howeverit is not necessary to perform bit insufficient regulated treatment in the coding correction circuit 314.

[0046]Heredetails about regulated treatment in bit remainder of **** are explained about a flow chart of drawing 4. By step ST-1after setting the block number NO to zeroit shifts to step ST-2 and it is judged whether it is bit assignment =0. When judgment of step ST-2 is YESshift to step ST-3set a bit necessity degree as the maximum of an absolute value of a signal component within a bit necessity degree = blockand at the time of NO. It shifts to step ST-4 and a bit necessity degree is set as a bit necessity degree = peak child-ized error (QV/2). Step ST-After 3 and 4 shifts to step ST-5.

[0047]Step ST-In 5judge whether it is the number of recording blocks = block number+1and if the number of recording blocks is NOAfter it shifts to step ST-6 and only 1 increases the block number NOit returns to step ST-2and if it is YESit will shift to step ST-7and it is judged whether an usable bit is an usable bit >= quota bit total.

[0048]By step ST-7it shifts to step ST-9 at the time of NOand bit insufficient processing (processing after step ST-9 in drawing 5) is performedit shifts to step ST-8 at the time of YESand it sets a whole block as a block which can be adjusted. It is judged whether after step ST-8 shifts to step ST-10and a block which can be adjusted exists. By judgment of step ST-10it becomes the end at the time of NOit shifts to step ST-11 at the time of YESand a bit necessity degree detects the greatest block during [which can be adjusted] a block.

[0049]After step ST-11 shifts to step ST-12and it is judged whether an increase in a single step of bit assignment of a detected block is possible. At the time of NOit shifts to step ST-14 in step ST-11After carrying out the setting variation of the detected block to an adjustment improper block from a block which can be adjustedit returns to step ST-10and it shifts to step ST-13 at the time of YESand the increase in a single step of the bit assignment of a detected block is carried out.

[0050]After step ST-13 computes a bit necessity degree of a detected block by shifting to step ST-15 <peak child-ized error QV/2>. After step ST-15 returns to step ST-11after

computing a quota bit total by shifting to step ST-16.
[0051]Although the above explanation described an example when there are few totals which totaled a computed quota bit than the usable number of bits and a bit has arisen not muchWhen a total which totaled a computed quota bit is insufficient of more bits than the usable number of bitsa direction which deletes a bit from whathas small operation contrary to an above-mentioned examplei.e.bit necessity degreebecomes realizable.
[0052]That isthere are more totals which totaled a computed quota bitfor example than the usable number of bitsand when an insufficient bit has arisena bit necessity degree detects the minimum unit blockand deletes a bit from the unit block. About a unit block which deleted a bitit is a bit assignment value after bit deletionand a bit necessity degree is recomputed by an above-mentioned method. Henceforthin the fraction equalization circuit 313a bit necessity degree detects the minimum unit blocka bit is deletedand processing of a series of calculation of a bit necessity degree recarrying out is repeated until a total of a quota bit becomes below in the usable number of bits. What is necessary is just to make it bit assignment except from an adjustment operation object about a unit block of 0 at this time.
[0053]Heredetails about adjustment operation when an above-mentioned bit is insufficient are explained with reference to drawing 5. By step ST-1after setting the block number NO to zeroit shifts to step ST-2 and it is judged whether it is bit assignment =0. When judgment of step ST-2 is YESshift to step ST-3set a bit necessity degree as the maximum of an absolute value of a signal component within a bit necessity degree = blockand at the time of NO. It shifts to step ST-4 and a bit necessity degree is set as a bit necessity degree = peak child-ized error (QV/2). Step ST-After 3 and 4 shifts to step ST-5.
[0054]Step ST-In 5judge whether it is the number of recording blocks = block number+1and if the number of recording blocks is NOAfter it shifts to step ST-6 and only 1 increases the block number NOit returns to step ST-2and if it is YESit will shift to step ST-7and it is judged whether an usable bit is an usable bit >= quota bit total. Processing of step ST-1 - ST-7 is as common as bit remainder processing of drawing 4.
[0055]In step ST-7at the time of YESshift to step ST-8and perform bit remainder processing (processing after step ST-8 in drawing 4)and it shifts to step ST-9 at the time of NODuring [which can be adjusted] a block (block whose bit assignment is not 0)a bit necessity degree shifts to step ST-10after detecting the minimum ax block.
[0056]Step ST-In 10after decreasing bit assignment of a detected block by one stepit shifts to step ST-11. Step ST-In 11after computing a bit necessity degree of a detected blockit shifts to step ST-12. Step ST-In 12after computing a total of the quota number of bitsit returns to step ST-7.
[0057]Since it is also possible to carry out in a form independent of an input signalan above-mentioned fraction processFor examplebit remainder processing performs adjustment operation in a form which performs adjustment operation in a form where it asks for an above-mentioned bit necessity degree and for which it does not depend on an input signal about bit insufficient processingOr combination referred to as performing bit remainder processing in the form depending on an input signaland performing adjustment operation in a form where it asks for an above-mentioned bit necessity degree about bit insufficient processing is also possible conversely.
[0058]A bit assignment value after an output from the fraction process circuit 313i.e.fraction adjustment of each unit blockis supplied to the coding correction circuit

314. In this coding correction circuit 314with the unit block in which the minimum carried out thing adoption in a scale factor (normalization data) (information-compression parameter) prepared beforehand. In spite of carrying out bit assignment of 2 bits or morea spectrum within a unit blockOr when all MDCT coefficients (signal component within a two-dimensional block about time and frequency) detect what will be quantized by 0 and set bit assignment of a unit block to 0A bit which was being used for numerals of spectrum data or a MDCT coefficient is omittedand a bit obtained by abbreviation is distributed more effectively.

[0059]Belowan example of correction in the coding correction circuit 314 is explained using drawing 12. Drawing 12 shows a situation of re quantization of unit Brock who has like drawing 11A lengthwise direction shall show a size of a spectrum or a MDCT coefficient (signal component in two-dimensional Brock about time and frequency)a transverse direction shall show frequencyand eight spectra or a MDCT coefficient exists in unit Brock. In this examplethe maximum of a spectrum in unit Brock or an absolute value of a MDCT coefficientIt is smaller than the minimum thing in a scale factor (normalization data) (information-compression parameter) prepared beforehandThe minimum thing is adopted in a scale factor for which this unit Brock's scale-factor value was prepared beforehandand it is 2 bitsand bit assignment shall have a quantized value of one every value and a total of three values in 0and for Masakata and a negative direction as it was shown in drawing 12.

[0060]Howeverwhen the maximum of a spectrum within a unit block or an absolute value of a MDCT coefficient is smaller than a value of a half of quantization width shown by a dotted line of drawing 12 like drawing 12 in the case of 2 bit assignmentall the spectra or MDCT coefficients within a unit block are quantized by 0. That isalthough it is coded by "00" and all of eight spectra of a-h need 16 bits for record of a spectrum at leastall quantized values are set to 0. In this caseby sub informationall records are set to 0 about a unit block. In this casesince it becomes possible [a spectrum within a unit blockor all MDCT coefficients] by not recording about that unit blocknamelychanging bit assignment with 0 bit by sub information etc. to regard it as 0It becomes possible to completely perform the same codingwithout using 16 bits which were being used for a spectrum or a MDCT quantization-of-coefficient value "00" in the case of above-mentioned 2 bit assignment. Namelyby setting bit assignment of the unit block to 0when all of a spectrum and a MDCT quantization-of-coefficient value are set to 0although there is 2-bit or more assignment within a certain unit blockIt is possible to omit a spectrum or a bit which was being used for coding of a MDCT coefficientand to completely perform the same coding.

[0061]Also when it is not 2 bit assignment as shown in drawing 12about a unit block with which the minimum thing in a scale factor (normalization data) (information-compression parameter) generally prepared beforehand was adopted as a scale-factor value. All spectra or MDCT quantization-of-coefficient values within a unit block which fulfills conditions of the several 3 following formula are set to 0 using the quantization width QV of a unit block searched for by several 2 above-mentioned formula by setting the maximum of an absolute value of a spectrum within the unit blockor a MDCT coefficient to SPmax.

[0062]In the coding correction circuit 314it is an above-mentioned method and a new usable bit can be obtained by detecting a unit block in which coding correction is possible using several 3 formula shown belowand correcting bit assignment to 0.

[0063]
[Equation 3]SPmax <QV/2[0064]Although based on the format of codingFor examplein addition to the method of setting bit assignment to 0 by the sub information which shows substantial bit assignmentIf not coding a block by the sub information which shows the validity of the unit block is shown when there is validity of a unit blocki.e.the information which shows whether lends and there is in recording a unit blockSince the abbreviation of the bit of the scale factor which is the sub information of the processing blockand the sub information which was being used for bit assignment is also attainedIn such a caseeven if it attachesby the coding correction circuit 314 in drawing 3sub information can be changed into the adapted forma bit can be omittedand a new usable bit can be obtained.
[0065]In the coding correction circuit 314when correction by an above-mentioned method is possiblereallocation which is the newly gained usable bit is performedbut it is clear that adjustment operation by bit required ** degree calculation of a unit block performed in the above-mentioned fraction equalization circuit 313 can be used in the case of this reallocation. Data corrected by this coding correction circuit 314 is outputted as an output of the bit quota calculation circuit 118 in drawing 1 from an output terminal.
[0066]Namelyin the bit quota calculation circuit 118 in drawing 1. Data which processed an orthogonal transformation output spectrum sub information as main information by a system shown in drawing 3 mentioned aboveWord length which shows a scale factor (normalization data) (information-compression parameter) and a word size who show a state of block floating as sub information is obtainedBased on thisit codes in a form in drawing 1 which actually performed re quantization and followed a coding format in the adaptation bit allocation code-ized circuits 106107and 108.
[0067]With reference to drawing 13a decoder of a signal by which high efficiency coding was carried out with an encoder shown by drawing 1 mentioned above is explained. A MDCT coefficient by which each zone was quantizedi.e.data equivalent to an output signal of the output terminals 112114and 116 in drawing 1Block size information used having supplied the input terminal 1307 in drawing 13 (the length of a processing block) (information-compression parameter)i.e.data equivalent to an output signal of the output terminals 113115and 117 in drawing 1is supplied to the input terminal 1308 in drawing 13. In the adaptation bit quota decoding circuit (adaptation bit quota decoding means) 1306bit assignment is canceled using adaptation bit assignment information. Nexta signal on a frequency axis is changed into a signal on a time-axis in the inverse-orthogonal-transformation (IMDCT) circuits (inverse-orthogonal-transformation means) 13031304and 1305. A time-axis top signal of these partial zones is decrypted by all the zone signalsand is outputted to the output terminal 1300 by the band composing filter (IQMF) circuits (band composition means) 1302 and 1301 in drawing 13.
[0068]Nextwith reference to drawing 14 - drawing 17an embodiment of a digital signal recorder (a method) of this inventiondigital signal playback equipment (a method)a digital signal sending set (a method)and a digital signal receiving set (a method) is described. In drawing 14 and drawing 16ENC shows an encoder of drawing 1Tin shows the input terminal 100DEC shows a decoder of drawing 13and Tout shows the output terminal 1300.
[0069]In a recorder of drawing 14supply an input digital signal from the input terminal Tin to the encoder ENCand it is encodedAfter carrying out predetermined abnormal

conditions after supplying the output terminals 112114and 116 of an output of the encoder ENCi.e.an encoder of drawing 1and an output signal from 113115and 117 to modulation means MOD and multiplexing themor modulating each output signalrespectivelymultiplexing or a second change tone is carried out. By recording devices (a magnetic headan optical headetc.)a modulating signal from modulation means MOD is recorded on the recording medium M.

[0070]In playback equipment of drawing 15a record signal of the recording medium M of drawing 14 is reproduced by the reproduction means (a magnetic headan optical headetc.) Pand a recovery according to abnormal conditions according the regenerative signal to modulation means MOD by the demodulation means DEM is performed. Supply a signal corresponding to a demodulation output from the demodulation means DEMi.e.an output from the output terminals 112114and 116 of an encoder of drawing 1to the input terminal 1307 of a decoder of drawing 13and. A signal corresponding to an output from the output terminals 113115and 117 of an encoder of drawing 1 is supplied to the input 1308 of drawing 13is decodedand an output digital signal corresponding to an input digital signal is outputted to the output terminal Tout.

[0071]In a sending set of drawing 16supply an input digital signal from the input terminal Tin to the encoder ENCand it is encodedAfter carrying out predetermined abnormal conditions after supplying the output terminals 112114and 116 of an output of the encoder ENCi.e.an encoder of drawing 1and an output signal from 113115and 117 to modulation means MOD and multiplexing themor modulating each output signalrespectivelymultiplexing or a second change tone is carried out. A modulating signal from modulation means MOD is supplied to the transmitting means TXfrequency conversionamplificationetc. are performeda sending signal is madeand the sending signal is transmitted by transmission antenna ANT-T which is a part of transmitting means TX.

[0072]In a receiving set of drawing 17receiving antenna ANT-R which is a part of reception means RX receives a sending signal from transmission antenna ANT-T of drawing 16and reception means RX performs the input signal for amplificationreverse frequency conversionetc. A recovery according to abnormal conditions according an input signal from reception means RX to modulation means MOD by the demodulation means DEM is performed. Supply a signal corresponding to a demodulation output from the demodulation means DEMi.e.an output from the output terminals 112114and 116 of an encoder of drawing 1to the input terminal 1307 of a decoder of drawing 13and. A signal corresponding to an output from the output terminals 113115and 117 of an encoder of drawing 1 is supplied to the input 1308 of drawing 13is decodedand an output digital signal corresponding to an input digital signal is outputted to the output terminal Tout.

[0073]It is also possible for this invention not to be limited only to an above-mentioned embodimentand for bit reduction and an expanding device not to be further united with an above-mentioned recording and reproducing mediuma bit reduction deviceor an expanding devicefor examplewithout passing a recording mediumand to connect the meantime with a circuit for data transferetc. For exampleit is applicable not only to an audio PCM signal but signal processorssuch as a digital audio signal and a digital video signal.

[0074]The recording medium of this invention can aim at effective use of storage capacity by recording data compressed by an above-mentioned digital signal processing device. It can also be considered as a card which contains not only an optical disc

mentioned above but a magnetic diskan IC memoryand its memory as a recording medium of this inventionand various recording mediasuch as magnetic tape.

[0075]

[Effect of the Invention]According to above-mentioned **** this inventionan input digital signal is divided into two or more frequency band componentsObtain the signal component within time and two or more two-dimensional blocks related with frequencyand normalize based on the signal component within a two-dimensional block for every two-dimensional block about time and frequencyand normalization data is obtainedThe quantization coefficient which expresses the feature of the signal component within a two-dimensional block for every two-dimensional block about time and frequency is calculatedDetermine bit allocation quantities based on the quantization coefficientfor every two-dimensional block about time and frequencyquantize the signal component within a block with normalization data and bit allocation quantitiesand carry out an information compressionand. A digital signal processing method which obtained the information-compression parameter for every [about time and frequency] two-dimensional blockA digital signal processing devicea digital signal record methoda digital signal recordera recording mediuma digital signal transmission methodBy or the relation which performs integer-ization of bit allocation quantitiesetc. in a digital signal sending set when bit allocation quantities are computed for every two-dimensional block about time and frequency. When the total of the quota bit of all the two-dimensional blocks is not in agreement with the bit rate specified by a coding formatin order to coincide thisThe amount of bit assignment and normalization data which were provisionally computed for every two-dimensional block about above-mentioned time and frequencyOr based on the greatest signal component within a two-dimensional blockthe greatest quantization error that may happen within a two-dimensional block is computedSince it considers that the greatest quantization error is a bit necessity degree of two dimension blocks each and was made to perform adjustment operation of the bit based on the bit necessity degreeAdjustment operation depending on an input digital signal can be performedmore efficient coding can be realized by a throughput suitable as adjustment operationand what can aim at improvement in a static characteristic or a signal quality can be obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block circuit diagram showing one example of a highly efficient compression encoding encoder usable to the bit rate compression encoding of an embodiment of the invention.

[Drawing 2]It is a figure showing the structure of the orthogonal transformation block in the case of bit compression.

[Drawing 3]It is a block circuit diagram showing the example of a bit distribution calculation function.

[Drawing 4]It is a flow chart which shows the regulated treatment of bit remainder.

[Drawing 5]It is a flow chart which shows regulated treatment with an insufficient bit.

[Drawing 6]It is a figure showing the spectrum of the zone divided in consideration of

each critical band and block floating.
[Drawing 7]It is a figure showing a masking spectrum.
[Drawing 8]It is the figure which compounded the minimum audible curve and the masking spectrum.
[Drawing 9]It is a figure showing the total amount remedial operation which pulls up the amount of bit assignment uniformly.
[Drawing 10]it is a figure showing the total amount remedial operation which boils the amount of bit assignment uniformly and reduces it.
[Drawing 11]It is a figure showing the example of quantization of the signal component in a bit assignment unit block.
[Drawing 12]In a bit assignment unit blockall signal components are the figures showing the example quantized by 0.
[Drawing 13]It is a block circuit diagram showing one example of a highly efficient compression encoding decoder usable to the bit rate compression encoding of an above-mentioned embodiment.
[Drawing 14]It is a block diagram showing the recorder of an embodiment of the invention.
[Drawing 15]It is a block diagram showing the playback equipment of an embodiment of the invention.
[Drawing 16]It is a block diagram showing the sending set of an embodiment of the invention.
[Drawing 17]It is a block diagram showing the receiving set of an embodiment of the invention.
[Description of Notations]
101 and 102 A zone dividing filterand 103104 and 105 Orthogonal transformation circuit (MDCT)109110and 111 A block determining circuita 118 bit-assignment calculation circuit106107and 108 An adaptation bit allocation code-ized circuit and the 302 whole zones Energy calculation machineA 303 reefing filter and 304 An adding machine305 function generators306 dividers307 A composing device and 308 A subtractor309 delay circuitsand 310 Permissible noise amendment machine312 The minimum audible curve generatora 313 fraction equalization circuitand 314 A coding correction circuit13011302 band composing filters (IQMF)and 13031304 and 1305 An inverse-orthogonal-transformation circuit (IMDCT) and 1306 Adaptation bit quota decoding circuit.